Generating a Reduced Gravity Environment on Earth

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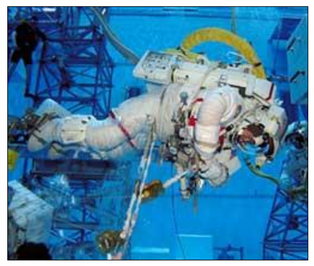
Overview

The **Active Response Gravity Offload System (ARGOS)** is designed to simulate reduced gravity environments, such as Lunar, Martian, or microgravity using a vertical lifting hoist and horizontal motion system. Three directions of motion are provided over a 41’ x 24’ x 25’ tall area. ARGOS supplies a continuous offload of a portion of a person's weight during dynamic motions such as walking, running, and jumping. The ARGOS system tracks the person's motion in the horizontal directions to maintain a vertical offload force directly above the person or payload by measuring the deflection of the cable and adjusting accordingly.

The facility will be capable of supporting the following:

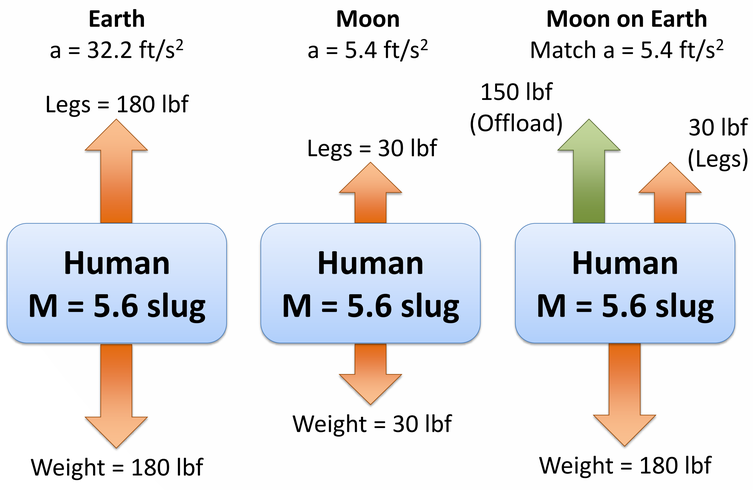
- Surface operation studies, tool development, and crew training
- Suit and vehicle requirements development and design evaluation
- Testing of rovers and robots in simulated reduced gravity environments.

History of Offload Systems



Gravity offloading devices are nothing new for the space program. Specialized aircraft fly parabolic trajectories to provide brief reduced gravity environments. Underwater environments, such as the Neutral Buoyancy Laboratory, are often used at NASA for microgravity simulation. Land based simulators have made use of inclined surfaces, pneumatic pistons, and springs to provide offload forces for participants. Each of these systems has unique limitations, such as short durations, limited degrees of freedom, small work areas, low simulation fidelity, and cost.

Theory of ARGOS

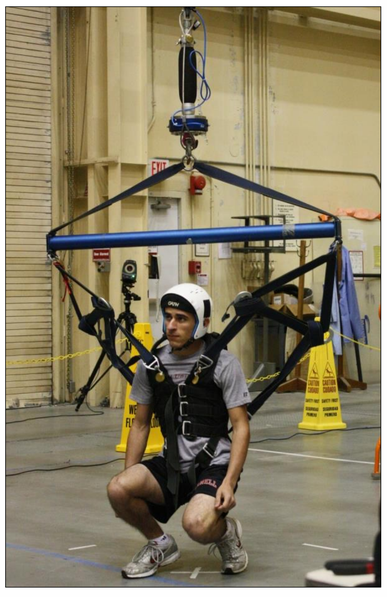


ARGOS works by applying a constant upwards force to a payload. Mass remains constant and is independent of gravity, while weight is a direct function of gravitational acceleration. In the above example, a 180lbf person on Earth (mass of 5.6 slug) would weigh 30lbf on the Moon. In order to simulate the Moon’s reduced gravity environment on Earth, an upwards force of 150lbf must be applied by ARGOS. With the 150lbf offload force, the effective acceleration due to gravity is now 5.4 ft/sec^2.

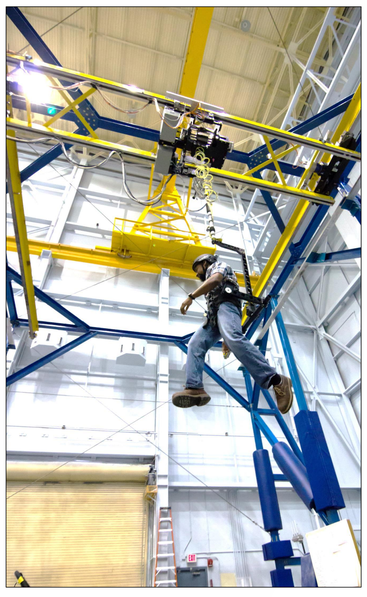
Gimbal Interface

A gimbal is the primary interface of the human to the system and is critical in providing the full range of movement. While ARGOS provides the three translational degrees of freedom, a gimbal must be used to provide the three rotational degrees of freedom. A new gimbal has been designed which greatly improves this interface and allows the participant to pitch, roll, and yaw about their center of gravity. The gimbal is also designed to minimize its inertial effects seen by the participant to provide the most realistic simulation.

Other, specialized gimbals are currently being designed and tested for specific situations in ARGOS, such as a gimbal designed solely for a microgravity environment with a participant in the horizontal orientation or for space suit testing.



Spreader Bar and Harness
No Rotational Abilities



Gimbal System
Six Degrees of Freedom within ARGOS

Future of ARGOS

The ARGOS system is currently a developmental project. The long term goals include creating a larger facility to allow for integrated, large scale testing to be accomplished (right).

In addition, the project will develop additional control system improvements to increase both the accuracy and safety of the system. Finally, the human gimbal interfaces will be continually improved for maximum performance and comfort.